Request for Approval-to-Construct
The American Centrifuge Plant
On the Piketon Ohio DOE Reservation

Summary

This document requests the United States Environmental Protection Agency (EPA) Approval to Construct under 40 Code of Federal Regulations (CFR) 61.07 the American Centrifuge Plant (ACP) by USEC, Inc. on U.S. Department Of Energy (DOE) Piketon reservation. The ACP will enrich uranium in the form of UF_6 for civilian power generation and will replace DOE's older Gaseous Diffusion Plant (GDP) on the same reservation. The following sections briefly describes the process and site and then describe the individual facilities with their emission points and emission controls in greater detail. The facilities that actually process UF_6 outside of sealed containers are described first in the order that they occur during the enrichment process, followed by the support faculties which may have minor quantities of radionuclides present at some time or which may include sealed containers of uranium hexafluoride (UF_6).

The document then addresses the radionuclides potentially present in ACP emissions, the maximum anticipated emissions of those radionuclides, and summarizes the results of a public dose assessment (CAP88-PC) based on the maximum anticipated emissions. The result of the modeling indicated a maximum plausible annual dose to a member of the public of only 0.3 mrem/year. The reports generated by CAP88-PC are attached as supporting documentation.

The final sections describe the ACP emission monitoring program (based on the existing GDP program) and summarize the process for the ACP's annual demonstration of compliance with NESHAP.

Process Description

This section describes the buildings and facilities that comprise the ACP located on the DOE reservation in Piketon, Ohio, and describes the process by which the plant will operate. The uranium element appears in nature in numerous isotopes; the three major isotopes of interest have atomic weights of 234, 235, and 238. The ^{235}U isotope is easily fissionable and capable of sustaining a critical reaction. Natural uranium contains 0.711 percent ^{235}U isotope. Isotopic separation processes separate uranium into two fractions, one enriched in the ^{235}U isotope, and the other depleted.

Prior to the enrichment process, uranium is combined with fluorine to form UF_6 at a conversion facility. The UF_6 arrives at the plant in a solid state and this UF_6 is sublimed from a solid to a gas and fed into the system. In the gas centrifuge process, the isotopic separation is accomplished by centrifugal force, which uses the difference in weight of the uranium isotopes to achieve this isotopic separation. UF_6 can be enriched up to 10 wt. percent assay ^{235}U in the ACP. The plant withdraws the enriched (product) stream and the depleted (tails) stream in the gaseous state. The product and tails streams are then desublimed back into a solid state for handling and movement. The plant minimizes the amount of UF_6 in the liquid state to minimize the risk of a large accidental UF_6 release. Only quality control sampling according to the applicable American Society for Testing and Materials (ASTM) standard and final packaging of product material for shipment to customers will involve liquefied UF_6. These actions will take place within pressure-rated autoclaves.

Two process buildings are included in the initial deployment of the ACP to support a nominal capacity of 3.8 million separative work units (SWU) per year production capacity with centrifuge machines arranged in cascades.

Site Description

The ACP is located approximately one and one half miles east of U.S. Route 23 on an approximately 3,700 acre DOE reservation. The reservation also contains the Portsmouth GDP, constructed in the 1950's, and DOE's new DUF_6 Conversion Project, currently under construction. The area around the reservation is sparsely populated, with the nearest residential center located approximately four miles to the north of the reservation. The ACP is located in the southwest quadrant of the reservation and is situated on approximately 200 acres. Proximity of the ACP to the nearest member of the public (i.e., permanent residence) is about 2,200 feet (ft) [670 meters (m)].

Facilities Description

The ACP utilizes buildings and facilities that were part of DOE's Gas Centrifuge Enrichment Plant (GCEP), built in the early 1980s, part of DOE's GDP that was built in the early 1950s, and newly constructed buildings and facilities. A brief listing of the main buildings and facilities utilized for the ACP and their function is located in Table 1. The primary facilities directly involved in the enrichment process are the X-2232C Interconnecting Process Piping (IPP), X-3001 Process Building; X-3002 Process Building; X-3012 Process Support Building; X-3346 Feed and Customer Services Building; X-3346A Feed and Product Shipping and Receiving Building; and X-3356 Product and Tails Withdrawal Building. Other buildings and areas that provide direct support functions to the enrichment process are the X-7725 Recycle/Assembly Facility; X-7726 Centrifuge Training and Test Facility; X-7727H Interplant Transfer Corridor; X-745G-2 Cylinder Storage Yard; X-745H (future) Cylinder Storage Yard, X-7756S (future) Cylinder Storage Yard; and X-7746N, X-7746S, X-7746E, X-7746W (future) Cylinder Storage Yards and the Intraplant Roadways.

X-3346A Feed and Product Shipping and Receiving Building

The X-3346A building is located in the southwest quadrant of the DOE reservation approximately 300 ft south of the X-3346 building. The building measures approximately 100 ft in width, 40 ft in height, and 190 ft in length with a covered floor area of approximately 19,000 ft^2. This building serves as the focal point for the receipt and shipping of natural and enriched uranium in U.S. Department of Transportation (DOT) approved cylinders and Protective Shipping Packages, as required. The nearest reservation boundary is 1,755 ft to the south of the X-3346A building.

The X-3346A building is connected to the X-3346 building by a bridge crane rail system that serves both the X-3346 and X-3346A buildings. X-3346A has doors on the north and south sides of the building for either trucks (tractor trailer) or cylinder handling equipment or cranes utilized for movement of cylinders.

The X-3346A building contains the operations associated with receiving full UF_6 feed cylinders and returning empty feed cylinders to vendors and the receipt of empty product cylinders and shipment of full product cylinders to customers. The building includes a large shipping and receiving area, a cylinder staging area, offices, and a trucker's rest area. Aside from the storage and movement of closed cylinders of UF_6, there are no radioactive operations in the X-3346A.

<u>X-3346 Feed and Customer Service Building</u>

The X-3346 building is located in the southwest quadrant of the DOE reservation. The X-3346 building is located approximately 1,000 ft south-southwest of the X-3001 building. The nearest reservation boundary is 1,865 ft to the west of the X-3346 building. The X-3346 building is connected to the X-3001 and X-3002 buildings by the X-2232C piping.

The X-3346 building has a covered floor area of approximately 154,000 ft^2 with two distinct areas of operation to meet process feed, sampling, and transfer requirements. The X-3346 building has two distinct areas of operation. The first area, referred to as the Feed Area, supports the front end of the overall enrichment process by housing the equipment necessary to provide UF_6 feed. The second area, referred to as the Customer Services Area, supports the back end of the enrichment process by housing the sampling equipment necessary to ensure customer products meet specifications and to transfer UF_6 material to customer cylinders. Both areas have functionally identical emission control systems, consisting of a gaseous emission control sub-system and a particulate emission control sub-system. The emission control systems for both areas may be combined in the final design of the ACP.

The Feed Area of the X-3346 building houses electrically heated feed ovens. UF_6 feed is processed through purification burp systems before being fed into the process manifolds/piping. There are separate manifolds that direct each stream to the X-3001 and X-3002 buildings. The Feed Area has accountability scales for weighing the feed cylinders. The feed oven's location provides the bridge crane sufficient room to transport the UF_6 cylinders between rows of ovens. Cylinders are placed on rail-carts that move the cylinders into and out of the feed ovens.

The Customer Services Area is the only building where liquid UF_6 may be present and provides a confinement barrier should an accident occur during sampling and transfer activities. In the Customer Services Area, the usual approach to product operations is to liquefy the UF_6 contained in 10-ton source cylinders, sample the liquid, transfer the material to the required number of 2.5-ton customer cylinders (typically three to four), then allow the customer cylinders to cool until the UF_6 has re-solidified. However, any approved UF_6 container may be heated in an electrically heated containment autoclave for sampling and transfer purposes. Cooling capability is supplied to expedite the cylinder heel cool-down process and shorten the cycle time.

The receiving UF_6 cylinder lines and valves are kept warm during the transfer. When the transfer is complete, the cylinders are cooled in combination with autoclaves/freezers that also provide containment. The parent cylinders and the receiving cylinders are enclosed in containment autoclaves when the UF_6 is in the liquid phase, to minimize the potential for a release of liquid UF_6.

The cylinder burping/heeling system, feed ovens, autoclaves, sampling system, and process piping in both areas are manifolded to the gaseous effluent side of their respective evacuation systems. Gases evacuated from process systems, which can contain high concentrations of UF_6, are processed through cold traps to desublime the UF_6 and separate it from the non-UF_6 gases. Residual gases leaving the cold trap have a very low concentration of UF_6, which is further reduced by passing the gas through an absorbent trap. When an evacuation system cold trap becomes full, it is valved off from the vent and its contents sublimed to a drum so the material can be fed to the enrichment plant. The cold traps can be bypassed to allow rapid evacuation of a volume that does not contain radioactive material. The absorbent traps cannot be bypassed.

Cylinder connections and disconnections have the greatest potential for small releases of UF_6 to the workspace. UF_6 released in this manner reacts quickly with ambient humidity to form UO_2F_2, which is a particulate. Gulper systems are used to collect any small release of material during these operations. Gulper systems utilize a flexible hose or hood to evacuate the air in the immediate area where the connection is being made or broken. The captured gases are passed through a roughing filter followed by a High Efficiency Particulate Air (HEPA) filter to collect the UO_2F_2 particulate.

The effluents from both sub-systems are combined and vented to the atmosphere through a common vent after each subsystem has removed the uranium. Each vent is equipped with continuous gas flow monitoring instrumentation with local readout as well as the analytical instrumentation required to continuously sample, monitor and to alarm UF_6 breakthrough in the effluent gas stream. The continuous vent monitor is functionally identical to continuous vent monitors used for NESHAP compliance monitoring by the GDP and are described in detail in a separate section below.

<u>X-2232C Interconnecting Process Piping</u>

The X-2232C piping includes any process piping that is external to the primary facilities. The X-2232C piping is the piping that connects the X-3346 building to the X-3001 and X-3002 buildings and the piping that connects the X-3001 and X-3002 buildings to the X-3356 building in the southwest quadrant of the DOE reservation. The nearest reservation boundary is 2,225 ft to the west of the X-2232C piping.

The X-2232C piping is typically located in a series of elevated enclosures or modules that run from the X-3346 building to the X-3001 building valve house (approximately 1,700 ft) and then to the X-3002 valve house (approximately 800 additional ft). The standard X-2232C piping module is approximately 40 ft long. Some piping modules are of non-standard lengths or shapes to accommodate vertical loops to give extra clearance across roadways and to fit-up to buildings. The X-2232C piping enclosures are insulated to minimize heat loss and heated to prevent the freeze-out of UF_6.

Since the X-3356 building is directly adjacent to both the X-3001 and X-3002 process buildings, the process piping runs are minimized, but are still considered the X-2232C piping system.

There are no routine radioactive emissions from the X-2232C Interconnecting Process Piping.

X-3001/3002 Process Buildings

The initial deployment of the ACP includes two process buildings, which are located in the southwest quadrant of the DOE reservation: X-3001 and X-3002. The primary purpose of the process buildings is to house the centrifuge machines and support systems necessary to perform the actual enrichment process. Both buildings are similar in construction, layout, and design. Each building is approximately 416 feet (ft) by 730 ft (approximately 304,000 square feet [ft^2]) and has a large high bay process area and two utility areas. The height of each building is approximately 87 ft in the high bay area and 49 ft in the utility areas. The nearest reservation boundary is 2,606 ft to the west of the X-3001 building. The X-3002 is east of the X-3001.

At the north and south ends of X-3001 and X-3002 buildings are equipment/utility bays and mezzanines where auxiliary equipment is housed. Items in these areas consist of heating and ventilation equipment, cooling water pumps, vacuum pumps, electrical switchgear, and standby electrical equipment (i.e., diesel generators, battery rooms, and uninterruptible power supply [UPS] systems). Building vents for the purge and evacuation vacuum systems are also located in the buildings

The east side of the X-3001 building is connected to the X-3012 building, which is connected to the west side of the X-3002 building. The X-7727H corridor is connected to the west side of the X-3001 building. The X-2232C piping connects to the southwest corner of the X-3001 building.

The centrifuge machines are installed in the high bay area in a cascade arrangement. The cascades are supplied UF_6 feed from a header from the X-3346 building. The machines in each cascade are grouped into stages that are connected in series. The feed, product, and tails lines to and from each centrifuge within a stage connect into stage headers that convey the UF_6 streams between stages. The depleted material from the bottom stage is piped to the X-3356 building to be withdrawn as tails. The enriched material from the top stage is piped to the X-3356 building to be withdrawn as product. The cascade enrichment is normally less than 5.5 wt. percent ^{235}U, but enrichment levels up to 10 wt. percent ^{235}U are allowable.

Enrichment equipment operates at sub-atmospheric pressures. Equipment operation requires the removal of any air that leaks into the process. The PV/EV Systems are used to remove air in the enrichment equipment. Each individual cascade has a Purge Vacuum (PV)

System that operates continuously to remove any inleaked air before it reaches the UF_6. In addition, each train of six cascades has an Evacuation Vacuum (EV) System that operates as needed to remove any air from newly installed equipment before it goes online. Since the air may contain traces of UF_6 the gas removed by these systems is passed through a shared set of absorbent traps prior to venting. The PV/EV systems in each half (north and south) of each process building are manifolded to one process building vent. Each process building vent is equipped with continuous gas flow monitoring instrumentation with local readout, as well as analytical instrumentation to continuously sample, monitor, and alarm UF_6 breakthrough in the effluent gas stream. The continuous vent monitor is functionally identical to continuous vent monitors used for NESHAP compliance monitoring by the GDP and are described in detail in a separate section below.

Valving and piping allow the EV systems to bypass the chemical traps during the initial pump down of machines that have not been previously exposed to UF_6. This reduces the chances of desorbing previously trapped UF_6 from the traps. Otherwise, the EV systems throughput will pass through the chemical traps along with PV system throughput.

<u>X-3356 – Product and Tails Withdrawal Building</u>

The X-3356 building is located in the southwest quadrant of the DOE reservation bounded on three sides by the X-3001 (to the west), X-3002 (to the east), and X-3012 buildings (to the north). The building has a covered floor area of approximately 36,000 ft^2 with two distinct areas of operation to meet the process withdrawal requirements: one for product withdrawal and the other for tails withdrawal. The nearest reservation boundary is 3,010 ft to the west of the X-3356 building.

The X-3356 building houses the equipment that functions to withdraw enriched and depleted UF_6 from the process. Product withdrawal is performed via sublimation into cold traps, which is then transferred to product cylinders. Different product assays can be withdrawn to the X-3356 building from the X-3001 and X-3002 buildings. Tails withdrawal is performed via compression and direct sublimation of the UF_6 into tail cylinders.

The X-3356 building withdraws and desublimes both the product and tail streams from the enrichment process and contains a variety of potential sources for radioactive effluents, both as gaseous UF_6 and particulate UO_2F_2. These sources are vented to atmosphere through evacuation systems similar to the X-3346 building. There are separate evacuation systems, with separate monitored vents, for the tails withdrawal and the product withdrawal areas. Both areas have functionally identical emission control systems, consisting of a gaseous emission control sub-system and a particulate emission control sub-system. The emission control systems for both areas may be combined in the final design of the ACP.

The tails burping system, cold boxes, sampling system, and process piping are manifolded to the gaseous effluent side of the appropriate evacuation system. Gases evacuated from process systems, which can contain high concentrations of UF_6, are processed through cold traps to desublime the UF_6 and separate it from the non-UF_6 gases. Residual gases leaving the cold trap have a very low concentration of UF_6, which is further reduced by passing the gas through an absorbent trap. When an evacuation cold trap becomes full, it is valved off from the vent and its contents sublimed to a cylinder. The evacuation cold traps can also be bypassed to allow rapid evacuation of a volume that does not contain significant amounts of radioactive material. The absorbent traps cannot be bypassed.

Cylinder connections and disconnections have the greatest potential for small releases of UF_6 to the workspace. UF_6 released in this manner reacts quickly with ambient humidity to form UO_2F_2, which is a particulate. Gulper systems are used to collect any small release of material during these operations. Gulper systems utilize a flexible hose or hood to evacuate the air in the immediate area where the connection is being made or broken. The captured gases are passed through a roughing filter followed by a HEPA filter to collect the UO_2F_2 particulate.

The effluents from both sub-systems are combined and vented to the atmosphere through a common vent after each sub-system has removed the uranium. Each vent is equipped with continuous gas flow monitoring instrumentation with local readout as well as the analytical instrumentation required to continuously sample, monitor and to alarm UF_6 breakthrough in the effluent gas stream. The continuous vent monitor is functionally identical to continuous vent monitors used for NESHAP compliance monitoring by the GDP and are described in detail in a separate section below.

<u>X-7725 – Recycle/Assembly Building and Gas Test Stand</u>

The X-7725 facility is located in the southwest quadrant of the DOE reservation. The X-7725 facility is connected to X-7726 facility and the X-7727H corridor and is located to the north of the X-3001 and X-3002 buildings. The X-7725 facility is approximately 540 ft x 820 ft (approximately 442,800 ft^2 area), and it contains a total floor space of about 837,900 ft^2 on five floors. The nearest reservation boundary is 2,431 ft to the west of the X-7725 facility.

The purpose of the X-7725 facility is to provide an area where centrifuge machines can be manufactured, assembled, tested, and maintained. This facility also includes an area for maintenance of the centrifuge transporters and other mobile equipment. The assembly of centrifuge machines begins with receipt of centrifuge machine components. Then these components are stored and staged for assembly. Centrifuge components and subassemblies are assembled into a complete centrifuge machine on one of the machine assembly stands. Other than the Gas Test Stand discussed in the next paragraph, there are no radioactive vents in the X-7725.

Some completely assembled centrifuge machines are tested with UF_6 in the Gas Test Stands. This is a separate room within X-7725 facility with its own ventilation and emission control system. UF_6 for the test stands is supplied from and recovered to a small cylinder within this room. Exhaust from the test stands' vacuum system passes through absorbent traps to a continuously monitored vent. The vent is equipped with continuous gas flow monitoring instrumentation with local readout, as well as the analytical instrumentation required to continuously sample, monitor, and to alarm UF_6 breakthrough in the effluent gas stream. The continuous vent monitor is functionally identical to continuous vent monitors used for NESHAP compliance monitoring by the GDP and are described in detail in a separate section below.

X-7726 Centrifuge Training and Test Facility

The X-7726 facility is located in the southwest quadrant of the DOE reservation. The X-7726 facility is connected and adjacent to the northwest corner of the X-7725 facility. The X-7726 facility has an overall height of approximately 80 ft, contains approximately 28,000 ft^2 of floor space at ground level and contains a total of 49,500 ft^2. The nearest reservation boundary is 2,431 ft to the west of the X-7726 facility. The facility was originally built to support training of plant personnel for centrifuge assembly and testing. This facility will initially be used for centrifuge component manufacturing and centrifuge machine assembly, and then primarily used for a machine assembly training and machine component preparation area for the ACP.

The X-7726 facility is an area where material and components are received; components or subassemblies are inspected and tested; the components are assembled as centrifuge machines; the final assembly is evacuated and leak checked; and repairs are performed to the machine or subassemblies until the X-7725 facility is available for use. Then these functions will be performed in the X-7725 facility. The X-7726 facility will then be used as a backup manufacturing/assembly area and may also be used for select repair of failed centrifuge machines or for disassembly of failed machines for failure analysis. The X-7726 facility will continue to be used as a training area for centrifuge subassembly preparation, column assembly, and machine assembly.

There are no radioactive vents in the X-7726.

X-7727H Interplant Transfer Corridor

The X-7727H corridor is located in the southwest quadrant of the DOE reservation. The nearest reservation boundary is 2,480 ft to the west of X-7727H corridor. The X-7727H corridor measures approximately 30 ft in width, 59 ft in height, and 750 ft in length. There are 55 ft by 25 ft doors located where the corridor meets the X-7725 facility and X-3001 building.

The X-7727H corridor is an elongated structure that connects the X-7725 facility with the X-3001 building. It provides a protected pathway to transport centrifuge machines from the X-7725 facility or X-7726 facility to the process buildings or back as necessary. The X-7727H corridor also serves as a shipping and receiving area for equipment and components during construction and operation activities. At the south end of the corridor is a smaller structure/service area, known as the service module unloading area.

There are no radioactive vents in the X-7727H, and no routine radioactive releases.

X-3012 Process Support Building

The X-3012 houses the operational area, maintenance area, and the transfer aisleway that services the X-3002 building. The X-3012 building is located between the X-3001 and X-3002 buildings. The X-3012 building, which is approximately 201 ft by 240 ft at grade level, has a ground floor area of approximately 48,000 ft^2, and has a total covered floor space area of approximately 56,200 ft^2, which includes the ground floor and two mezzanine areas. The transfer aisle way between the X-3001 and X-3002 and through the X-3012 building measures 30 ft wide by approximately 59 ft high by 200 ft long and divides the building into north and south sections. The north section is approximately 17 ft high and contains the operational area. The south section of the building is approximately 26.5 ft high and contains the maintenance areas. The nearest reservation boundary is 3,024 ft to the west of the X-3012 building.

The X-3012 building is divided into three functional areas: an operational area, maintenance area, and a machine transfer aisleway. The operational area is located in the north section of the building and includes the Area Control Room (ACR) for the X-3001 and X-3002 buildings; offices; lunchroom; restrooms; battery room; switchgear room; and heating, ventilation, and air conditioning (HVAC) rooms. A mezzanine above the north section contains the mechanical equipment room for the building. The ACR provides the central operating functions to monitor and control both the X-3001 and X-3002 building machines and processes. The maintenance area is located in the south section of the building and includes: maintenance shops, storage areas, a battery charging room, offices, men's and women's locker rooms, restrooms, and a mezzanine area with additional office areas and HVAC rooms. The X-7727H corridor is used for the transport of centrifuge machines into and out of the X-3002 building.

Access between the X-3001 and X-3002 buildings is provided via the transfer aisleway, which also provides access between the operational and maintenance areas of the X-3012 building.

There are no radioactive vents in the X-3012.

Workspace Ventilation in All Facilities

With the sole exception of liquid UF_6 sampling and transfer operations, UF_6 at the ACP will be at atmospheric or sub-atmospheric pressure in closed systems. Equipment requiring maintenance and connections being opened will be evacuated and purged prior to opening. Consequently, USEC, Inc does not anticipate any routine fugitive releases into the air during enrichment operations. Company experience has shown however that there will be occasions when small (less than a single gram) quantities of UF_6 become trapped in connections or on interior metal surfaces and create small fugitive releases when the connections are broken or systems are opened for maintenance.

The greatest chance of fugitive releases is at the UF_6 cylinder connections in X-3346 and X-3356. As described in the previous sections, there are fixed gulpers at the connection locations to capture any releases and exhaust any radionuclides through HEPA filters and monitored vents. A lesser chance of fugitive releases exists in the process buildings and in the maintenance areas of X-3012 and X-7725 where equipment may be disconnected or disassembled. These areas use portable gulpers with HEPA filters to capture fugitive releases. All of these areas are monitored by Health Physics to ensure that the workplace air concentrations are insignificant to worker health. Environmental Compliance personnel review summaries of the Health Physics data to ensure that ventilation exhausts are contributors to the public dose.

Cylinder Pads and Intraplant Roadways

No highways enter the DOE reservation. There are access roads that intersect with the Perimeter Road from four directions.

The reservation where the ACP is located has an extensive roadway system. The buildings/facilities on the reservation are serviced with a system of roads, which as a rule generally follow a north-south grid. The volume of traffic on the reservation is low and traffic is limited. Most plant personnel are required to use parking adjacent to the portals. The roadways allow for easy and safe movement of people, equipment, and material.

There are seven cylinder storage yards that support the ACP. Four of the yards are located adjacent to the X-3346 building (X-7746N, X-7746S, X-7746E, and X-7746W yards), one is adjacent to the X-3356 building (X-7756S yard) in the southwest quadrant of the DOE reservation, and the other two yards are located just north of the reservation Perimeter Road to the north of the GDP X-344 UF_6 Sampling Facility (X-745G-2 and X-745H yards).

All radioactive material in these yards or on the connecting intraplant roadways will be solid material under a vacuum in sealed steel cylinders. Consequently, there are no routine radioactive releases from these facilities.

Anticipated Maximum Radionuclide Emissions and Public Dose

Radionuclides Present in the ACP

Based on historic GDP experience and operating plans, the radionuclides anticipated to be present in ACP gaseous effluents are ^{234}U, ^{235}U, and ^{238}U. The intention is to not introduce feedstock contaminated with significant concentrations of other nuclides into the process. Feed material that meets the American Standards for Testing and Materials (ASTM) specification for recycled feed may be used in the ACP, and may contain traces of radionuclides such as ^{236}U, transuranics, or ^{99}Tc though. USEC, Inc.'s NRC License limits it to uranium material of ten percent assay or less.

Uranium-236 entered the fuel cycle in re-processed reactor fuel. It is an alpha emitter with a half life of 24 million years and a dose effect comparable to the three natural uranium isotopes. Because of its atomic mass, it tends to accumulate in enriched uranium. Based on historic experience at PORTS, ^{236}U will never make a measurable contribution to the public radiation dose. The highest concentration of ^{236}U in uranium assays of ten percent or less observed at PORTS was 880 ppm in January 1997. The average ^{236}U concentration observed by

USEC from 1995 until enrichment operations ceased at the PORTS GDP was only 72 ppm. At a maximum assay of ten percent, these concentrations would contribute less than a percent and less than a tenth of a percent of the public dose attributable to airborne uranium, respectively. The highest concentration of ^{236}U allowed under the ASTM Standard for commercial enriched uranium (250 ppm) would contribute less than a quarter of a percent of the public dose attributable to airborne uranium.

Transuranics are heavy elements created by neutron absorption and entered the fuel cycle in re-processed reactor fuel. The major transuranic nuclides (^{237}Np, ^{238}Pu, ^{239}Pu, ^{240}Pu, and ^{241}Am) are alpha emitters with half lives ranging from 86 years to over 2 million years. All five have similar dose effects (i.e., mrem/Ci inhaled or ingested) with up to 200 times the average dose effect (via inhalation) of the uranium isotopes present at the ACP. The ASTM Standard for UF_6 feedstock (ASTM Standard C787) sets equivalent limits of 0.676 µCi/kgU transuranics in the cylinder (i.e., including transuranics bonded onto the internal surfaces of the cylinder) or 0.089 µCi/kgU transuranics in the liquid UF_6 (i.e., measured as the cylinder is emptied). Natural uranium (i.e., feedstock) has an activity of 700 µCi/kgU. Assuming the ACP feedstock averaged the maximum allowable concentration of transuranics under the ASTM Standard and that those transuranics were released proportionally with the uranium, the transuranics would only account for 0.013 percent of the total alpha activity in the emissions. This alone would make the transuranics undetectable at the anticipated emission rates. Even adjusting for the difference in dose effects, this is still less than three percent of the public dose; well under the ten percent that requires inclusion in the dose assessment under 40 CFR 61 Subpart H.

Furthermore, In GDP experience transuranic hexafluorides have a tendency to bond strongly with exposed metal surfaces. This is the reason for having two different limits in the ASTM Standard. Sampling and analysis for transuranics in the same UF_6 stream will give drastically different results depending on whether the stream is entering a metal cylinder or being removed from one. As a result of this effect, any trace levels of transuranics in the UF_6 feedstock will rapidly become immobilized on the internal surfaces of the process equipment before they reach a vent.

Technetium-99 is a fission product and also entered the fuel cycle in re-processed reactor fuel. It is a beta emitter with a half life of 212 thousand years (comparable to ^{234}U) and has a weak dose effect relative to uranium isotopes. Relative to uranium, ^{99}Tc produces 180 times less dose equivalent per curie ingested. CAP88 predicts that ^{99}Tc will produce up to one eighth the dose equivalent per curie released due to bioaccumulation in plant tissues, however. The ASTM standard allows up to 0.5 ppm in UF_6 feedstock, and because ^{99}Tc has a relative high specific activity, because it concentrates strongly in enriched uranium, and because it is a beta emitter instead of an alpha emitter; detectable levels of ^{99}Tc may be found in ACP vents eventually.

Therefore, ACP effluents will be routinely analyzed for ^{99}Tc, ^{234}U, ^{235}U, and ^{238}U.

<u>Anticipated Emission Rates</u>

For the purposes of the NRC license for the ACP, USEC Inc. developed upper bounds for normal weekly radionuclide emission rates for each monitored release point based on historical experience with similar sources in the GDP. The specific values of these Baseline Effluent Quantities (BEQs) are given in Table 2 below.

The ACP BEQs are benchmark release rates that represent the anticipated maximum weekly release rates based on normal operation and historical experience with similar UF_6 handling systems in the adjacent GDP. The GDP BEQs were based on monitored releases and are defined as the greater of the arithmetic mean weekly release plus three times the standard deviation (i.e., the 99^{th} percentile in a normal distribution) or five times the minimum detectable weekly release and are calculated separately for uranium and technetium releases from each vent. The BEQs reflect conservative release rates. Historically (prior to the end of uranium enrichment at PORTS), GDP uranium releases have averaged ten percent or less of the BEQ, unless the BEQ was less than 0.01 millicuries per week (i.e., approaching detection-limit-based BEQ value). Average release rates from vents with detection-limit-based BEQs (i.e., the technetium BEQs) or BEQs that approached the detection-limit-based values normally saw average release rates close to twenty percent of the BEQ, which is equivalent to the detection limit.

The maximum anticipated gaseous effluents from the ACP have been modeled using the EPA dispersion model, CAP88-PC, and on-site meteorological data from calendar years 1998-2002. The source terms and the resulting airborne concentrations are summarized in Table 3. The maximum gaseous effluent anticipated under normal operations was 1.1 millicuries (mCi) of uranium over a week, or up to 0.057 curie (Ci) per year at the time of the modeling. The maximum exposed individual (MEI) for the ACP is located in the south-southwest sector of the reservation boundary. The projected maximum airborne concentration of total uranium due to ACP operations is only 3.2×10^{-15} µCi/mL, with an associated Total Effective Dose Equivalent (TEDE) of 0.3 mrem. This dose is comparable to the predicted TEDE produced by the GDP BEQs.

The dose assessment modeling was carried out by Alliant Corp using CAP88-PC Version 2 as part of the NRC License Application. The model reports generated are attached. To ensure conservative results over future residential patterns, a resident living at the site property line is assumed in each direction. Because CAP88-PC has no way of excluding any receptor points on its circular grid, the Summary Report presents results for a Most Exposed Individual (MEI) residing at the south end of the X-326 Process Building, a location near the physical center of the DOE reservation and not accessible to the public. The actual MEI is located at the south southwest corner of the reservation, due to proximity to the ACP and prevailing wind patterns. USEC, Inc has struck out (in red) grid points that are inaccessible to the public and highlighted (in yellow) the MEI results in the dose and concentration tables for the reviewer's convenience.

In the Summary Report; Source # 1 is the X-3346 Feed Area vent, Source # 2 is the combined PV/EV Vents, Source # 3 is the X-3356 Withdrawal vent(s), Source # 4 is the X-3346 Customer Services Area Vent, and Source # 5 is the X-710 Laboratory. The X-7725 Gas Test Stand and XT-847 Glovebox were not included because they accounted for less than one percent of the total anticipated emissions. The isotopic distribution for the sources were based on natural assay feedstock, an overall assay of two percent for the process, withdrawal and laboratory buildings, and a product assay of five percent for the Customer Service Area. USEC did not use the bounding assay of ten percent because the public dose is insensitive to assay due to the emission levels being based on activity instead of mass and the realistic assays gave more conservative results for airborne concentrations of uranium and HF.

Since the dose assessment was carried out, amendments to the input data have arisen. Because the original modeling report is already part of a public docket with the NRC and because the original results are conservative, USEC has not revised the assessment itself.

First, some of the original physical data for the vents themselves was inaccurate. The PV/EV Vents (Source # 2 in the CAP88 Summary Report) were modeled as 23 meters tall. The actual height is 30 meters, which would reduce the ground level impact. Also, all the vents were modeled as having a 0.05 meter diameter, when the actual diameter is 0.1 meters. This will have no effect since USEC assumes no plume rise for all UF_6 emissions.

Second, the X-710 Laboratory (Source # 5 in the Summary Report) has been dropped from the ACP License for business reasons. This reduces the projected source term by 0.0088 Ci of uranium per year (approximately 16 percent of the total), and will have the effect of reducing the projected public dose by the same fraction.

Finally, the modeling omits technetium because the anticipated emissions are zero. USEC has committed to monitoring for and has established BEQs for technetium based on the vent detection limits however. If the technetium BEQs were treated as actual releases, they would increase the source term by 0.047 Ci of ^{99}Tc per year. According to CAP88 and under the conditions present at PORTS, ^{99}Tc produces one eighth the public TEDE per curie released as uranium. Consequently, adding the hypothetical technetium releases to the source term is equivalent to adding 0.0059 Ci of uranium per year. This is less than the decrease attributable to the loss of the X-710, so the attached modeling reports are still a conservative estimate of the maximum plausible public dose due to normal operations even it technetium turns up in ACP effluents.

Radionuclide Emission Monitoring

Monitoring of Process Vents

Each process vent in the X-3001, X-3002, X-3346, X-3356, and X-7725 has gas flow monitoring instrumentation with local readout as well as analytical instrumentation to continuously sample, monitor and to alarm UF_6 breakthrough in the effluent gas stream. The continuous vent sampler draws a flow proportional sample of the vent stream through two alumina traps in series by way of an isokinetic probe. Both vent and sampler flows are monitored by the sampler's electronic controller. The controller adjusts a control valve in the sample line to maintain a constant ratio between the vent and sample flows. The flow instruments are calibrated at least annually. The primary sample trap is equipped with an automated radiation monitor to continuously monitor the accumulation of uranium in the sampler. This radiation monitor provides the real-time indicator of effluent levels for operational control of the gaseous effluent control systems. These monitors are based on the vent monitors used for approximately twenty years in the GDP and are identical to the monitor approved by the EPA for use in the American Centrifuge Lead Cascade.

Detailed effluent calculations are based on laboratory analysis of the collected samples. Each vent sampler has two traps permanently dedicated to each trap position, with one in-service and the other either being processed or standing by to replace the in-service trap. Normally, the primary sample traps are replaced weekly and the secondary traps are replaced quarterly. In the event of an unplanned or seriously elevated release, the involved sampler traps are collected for immediate analysis as soon as the situation has stabilized. Alternatively, the sampling period may be extended, provided the sampler is operating continuously while the vent is operating. A hydrated alumina is used in the vent samplers to convert absorbed UF_6 to UO_2F_2. The UO_2F_2 does not easily separate from the alumina, so no special handling is necessary to avoid loss of uranium between sample collection and analysis. Annually, the sampler tubing and traps are also replaced and rinsed, and the rinsates analyzed for the same parameters as the alumina.

Vent samples are analyzed for ^{234}U, ^{235}U, ^{238}U, and ^{99}Tc. GDP experience in uranium enrichment has shown that these three uranium isotopes account for more than 99 percent of the public dose due to uranium emissions. ^{99}Tc is a fission product that has contaminated much of the fuel cycle. Feed material that meets the ASTM specification for recycled feed may be used in the ACP, which may contain additional radionuclides (i.e., ^{236}U and ^{99}Tc). Based on GDP historic experience ^{99}Tc may eventually appear in some ACP gaseous effluents. The ACP therefore monitors process vent samples for technetium as a precautionary measure.

Weekly gaseous effluents are calculated based on the primary trap analytical results and measured flows. These are compared to the action levels in Table 4 to determine whether gaseous effluents are threatening to exceed ALARA goals or regulatory limits. The weekly effluents are also accumulated to provide source terms for the annual public dose assessment required under 40 CFR Part 61. Quarterly and annual corrections to the accumulated weekly effluents are calculated based on the secondary trap and rinsate analyses, respectively, to complete the annual source terms.

In the event of a radionuclide release outside the vent monitoring system, the activity of the release will be estimated based on available data and engineering calculations (e.g., inventory data and mass balances).

Monitoring Airborne Radioactivity in Breathing Air

The ACP air sampling program is consistent with the basic requirements of NRC Regulatory Guide 8.25, *Air Sampling in the Workplace*, Sections 1, 2, 5, and 6. A combination of low-volume, high-volume, and lapel air samplers are used for job coverage and general area air sampling. Low-volume air samplers are used for routine air sampling and are exchanged at least weekly. Due to radon and radon daughter products, routine air samples are allowed to decay for a minimum of three days.

Anticipated radionuclide concentrations in ventilation exhausts from occupied areas are insignificant contributors to the public dose. The results from the workplace monitoring program are reviewed by environmental engineers at least quarterly to verify this.

Air sample flow measurement devices are calibrated under standard laboratory conditions at least annually. The NIST traceable standards used have accuracy and precision of 20 percent or better. Lapel samplers are calibrated in accordance with a procedure.

Action Levels

Action levels for control of gaseous radioactive effluents from ACP operations have been established based on the ALARA philosophy. The action levels described in Table 4 ensure operational control system deficiencies are documented and acted upon in a responsible manner and in a timeframe to remain well within the regulatory limits and below ALARA goals. The BEQs used in Table 4 are the maximum effluents expected under normal operating conditions. BEQs have been established for every continuously monitored radiological vent. The specific current BEQ values established for the monitored ACP vents are listed in Table 2.

Annual Demonstration of Compliance

Characterization of the radiological consequences of radionuclides released to the atmosphere from the ACP is accomplished by annually calculating the TEDEs to the maximally exposed person and to the entire population residing within 80 kilometers (km) (50 miles) of the plant. The annual National Emission Standards for Hazardous Air Pollutants (NESHAP) Report includes the reservation identification, a description of plant operations during the previous year, the amount of radionuclides released to the atmosphere during the previous year, and the calculated TEDE to the most exposed member of the public.

Annual radionuclide releases to air are measured by the continuous vent samplers or estimated in accordance with guidance in 40 CFR Part 61, Appendix D. Atmospheric dispersion of the releases is modeled and the consequent public radiation dose is estimated using the EPA approved computer models in accordance with EPA guidance. An annual report summarizing the atmospheric releases and the dose assessment results is submitted in accordance with 40 CFR Part 61, Subpart H and EPA guidance, with a copy provided to the NRC. In accordance with EPA requirements, the reported public dose includes gaseous radioactive effluents from the DOE reservation.

The dose calculations are made using either the original CAP88 package of computer codes or the CAP88-PC package distributed by the EPA. The CAP88/CAP88-PC packages contain an EPA approved version of the AIRDOS-EPA and DARTAB computer codes and the ALLRAD88 radionuclide data file. (Version 3 of CAP88-PC replaces the ALLRAD88 data with more recent data from Federal Guidance Report # 13.) The AIRDOS-EPA computer code implements a steady-state, Gaussian plume, atmospheric dispersion model to calculate concentrations of radionuclides in the air and on the ground based on radionuclide releases to the atmosphere and annualized meteorological data. It then uses Regulatory Guide 1.109, *Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50,* Appendix I (October 1977), food-chain models to calculate radionuclide concentrations in foodstuffs (e.g., vegetables, meat, milk) and subsequent intakes by individuals. The DARTAB computer code then uses these calculated uptakes and radionuclide data from the ALLRAD88 data file to calculate annual radiation doses to members of the public.

The annualized meteorological data used in the calculations consist of joint frequency stability array distributions of wind direction, wind speed, and atmospheric stability that are prepared from data collected from the reservation meteorological tower. Data from the National Weather Service may be used in lieu of or to supplement reservation meteorological data in the event the on-site tower becomes inoperable. The reservation has a consistent annual pattern of low-level southwesterly winds predominating over the year. During the winter season, northeasterly winds are common though. This is largely attributable to the channeling effect of the hills and ridges on either side of the reservation, which runs roughly southwest to northeast.

Distances to the nearest residences are taken from U.S Geological Survey maps and population distributions are from the 2000 census data. EPA published default values for other off-site parameters (such as local crop productivity) are used in the AIRDOS-EPA model and, in accordance with EPA recommendations; rural patterns for food sources (i.e., home grown versus local production versus national supermarket chains) are assumed.

The ACP submits a written report to the EPA Regional Office, EPA Headquarters, OEPA, NRC Regional Office and the Office of Nuclear Material Safety and Safeguards by June 30 of each year detailing: plant operations and gaseous effluent monitoring during the previous calendar year, gaseous radioactive effluents over the previous year, an assessment of the public TEDE caused by those effluents, and an explicit comparison of the calculated TEDE to the EPA public dose limit (10 mrem annually). This report would become monthly if the maximum public TEDE exceeds 10 mrem annually.

This report is required under 40 CFR 61.94 and by the conditions of the Title V Permit issued by the State of Ohio. It also fulfills the requirement to demonstrate compliance with 10 CFR 20.1301 and 10 CFR 20.1101.

Table 1 American Centrifuge Plant Major Facilities

Facility No.	Facility Description	Facility Function	Emission Points
X-745G-2	Cylinder Storage Yard	Allows for movement and storage of UF_6 material outside of the process. (Typically Tails).	No airborne radioactive emissions during normal operations
X-745H	Cylinder Storage Yard	Future cylinder storage yard area reserved.	No airborne radioactive emissions during normal operations
X-2232C	Interconnecting Process Piping	Process piping that is external to the primary facilities that connects the X-3346 building to the X-3001 and X-3002 buildings and connects the X-3001 and X-3002 buildings to the X-3356 building.	No airborne radioactive emissions during normal operations
X-3001	Process Building	Houses the centrifuge machines and their support systems.	Two monitored vents for Purge Vacuum/ Evacuation Vacuum Systems
X-3002	Process Building	Houses the centrifuge machines and their support systems.	Two monitored vents for Purge Vacuum/ Evacuation Vacuum Systems
X-3012	Process Support Building	Houses the operational and maintenance areas and the transfer aisleway that services the X-3002 building.	No radioactive vents
X-3346	Feed and Customer Services Building	Supports the front end of the enrichment process by housing the equipment to provide UF_6 feed material. (Feed Area) Supports the back end of the enrichment process by housing the equipment to sample product material to ensure it meets customer specifications and to transfer UF_6 material to customer cylinders. (Customer Services Area)	One monitored vent with separate emission controls for gaseous UF_6 from piping and particulate UO_2F_2 from internal releases.
X-3346A	Feed and Product Shipping and Receiving Building	Supports the enrichment process by receiving UF_6 feedstock and shipping enriched UF_6 product in cylinders.	No airborne radioactive emissions during normal operations

Table 1 American Centrifuge Plant Major Facilities

Facility No.	Facility Description	Facility Function	Emission Points
X-3356	Product and Tails Withdrawal Building	Houses two distinct areas of operation to meet the process withdrawal requirements: one for product withdrawal and the other for tails withdrawal.	One monitored vent with separate emission controls for gaseous UF_6 from piping and particulate UO_2F_2 from internal releases.
X-7725	Recycle/Assembly Facility	An area where the centrifuge machines can be manufactured, assembled, tested, and maintained.	One monitored vent for Gas Test Stand. No other radioactive vents.
X-7745R	Recycle/Assembly Storage	Used mainly for clean, non-contaminated, outside, horizontal rack storage of centrifuge casings prior to being moved inside the building for machine assembly. Other centrifuge components and miscellaneous storage may also be temporarily stored in this area.	No airborne radioactive emissions during normal operations
X-7725A	Waste Accountability Facility	Serves as a storage area for equipment and parts necessary for the maintenance and repair of the process and process support equipment.	No airborne radioactive emissions during normal operations
X-7726	Centrifuge Training and Test Facility	Initially used for centrifuge component manufacturing and centrifuge machine assembly, then used for machine assembly training and machine component preparation.	No airborne radioactive emissions during normal operations
X-7727H	Interplant Transfer Corridor	Provides a protected pathway to transport centrifuge machines from the X-7725 or X-7726 buildings to the process buildings or back, as necessary. This area also serves as a shipping and receiving area for equipment and components during construction.	No airborne radioactive emissions during normal operations

Table 1 American Centrifuge Plant Major Facilities

Facility No.	Facility Description	Facility Function	Emission Points
X-7746E	Cylinder Storage Yard	Allows for movement and storage of UF_6 material outside of the process (product source cylinders, full and empty customer cylinders, and cylinder protective shipping packages).	No airborne radioactive emissions during normal operations
X-7746N	Cylinder Storage Yard	Allows for movement and storage of UF_6 material outside of the process (various cylinder types).	No airborne radioactive emissions during normal operations
X-7746S	Cylinder Storage Yard	Allows for movement and storage of UF_6 material outside of the process (full and empty feed cylinders).	No airborne radioactive emissions during normal operations
X-7746W	Cylinder Storage Yard	Allows for movement and storage of UF_6 material outside of the process (feed cylinders).	No airborne radioactive emissions during normal operations
X-7756S	Cylinder Storage Yard	Allows for movement and storage of UF_6 material outside of the process (product source cylinders).	No airborne radioactive emissions during normal operations

Table 2 Baseline Effluent Quantities for American Centrifuge Plant Discharges

Release Point	Total Uranium	Technetium
Vents		
X-3001 North Vent	0.2 mCi/week	0.1 mCi/week [a]
X-3001 South Vent	0.2 mCi/week	0.1 mCi/week [a]
X-3002 North Vent	0.2 mCi/week	0.1 mCi/week [a]
X-3002 South Vent	0.2 mCi/week	0.1 mCi/week [a]
X-3346 Feed Area Vent	0.02 mCi/week	0.1 mCi/week [a]
X-3346 Customer Services Area Vent	0.02 mCi/week	0.1 mCi/week [a]
X-3356 Tails Area Vent	0.02 mCi/week	0.1 mCi/week [a]
X-3356 Product Area Vent	0.02 mCi/week	0.1 mCi/week [a]
X-7725 Gas Test Stands Vent	0.01 mCi/week	0.1 mCi/week [a]

[a] Technetium BEQs for vents are based on five times the MDA.

Table 3 Anticipated Gaseous Effluents

Discharge Point	Total Uranium[a] μCi/mL[b]	Total Uranium[a] mCi/wk[c]	Technetium μCi/mL[b]	Technetium mCi/wk[c]
X-3346 Feed and Customer Services Building (2 vents)	<3.2 x 10^{-15}	<0.04	1.2 x 10^{-16}	0
X-3001 and X-3002 Process Buildings (4 vents)		<0.8		0
X-3356 Product and Tails Withdrawal Building Vent (2 vents)		<0.04		0
X-7725 Gas Test Stands Vent		<0.01		0
XT-847 Glovebox Vent		0.0004		0.005
Laboratory Hoods[d]		0.17[d]		0.035[d]
10 CFR Part 20, App. B, Table 2	3 x 10^{-12}	------	8 x 10^{-9}	------

[a] Since uranium isotopes present at the ACP have the same discharge limit, uranium isotope activities are combined into a Total Uranium activity for simplify comparison to the Table 2 limits.

[b] Anticipated concentrations are maximum ambient concentrations at the DOE reservation boundary due to emission sources and are based on emission estimates and atmospheric dispersion modeling. Anticipated technetium concentration is based on no detectable releases from the X-7725 facility and X-3000 series buildings.

[c] Anticipated discharges are measured at the vent and, by definition, are equal to or less than the Baseline Effluent Quantities. Anticipated technetium discharges from the X-7725 facility and X-3000 series buildings are zero.

[d] Laboratory services were originally included in the ACP License and the original public dose assessment as Source # 5, but have since been removed from the ACP design.

Table 4 American Centrifuge Plant Action Levels for Radionuclide Effluents

Weekly Sample Results		
Uranium [a]	Technetium [a]	Required Actions [b]
BEQ	BEQ	Review release data for previous six months for trends, and estimate probable impact over calendar year. Evaluate whether additional controls would significantly reduce public exposure.
10 x BEQ or 2 x BEQ averaged over 6 months	80 x BEQ or 16 x BEQ averaged over 6 months	Determine whether increased releases are ongoing or a single spike. Initiate investigation into cause(s) of increased releases. Evaluate whether mitigative and/or corrective measures are necessary to reduce public dose. Implement mitigative and/or corrective measures as needed.
EPA Reportable Quantity[c] (RQ) (0.1 Ci in 24 hours)	EPA RQ[c] (10 Ci in 24 hours)	Notify Operations Supervisor Trace source of abnormal releases and establish control or shutdown as needed. If releases cannot be mitigated within 24 hours, elevate to next level.
1 Ci[d]	8 Ci[d]	Close affected discharge points until control of releases is re-established.

[a] Uranium has an approximately 8-fold greater dose rate response than ^{99}Tc over air dominated exposure pathways. Uranium dose response completely dominates ^{99}Tc over water dominated exposure pathways.

[b] Required actions for any level include required actions listed under lower emission levels.

[c] RQ does not include permitted emissions. The ACP is regulated under 40 CFR Part 61, Subpart H for release of airborne radionuclides from the entire reservation up to the equivalent of 10 mrem/year TEDE to the most exposed member of the public.

[d] 1 Ci or 8 Ci in one weekly sample analysis.

Note: The Operations Supervisor has the authority to allow a restart.